Impact of FDI on Economic Development: A Causality Analysis for Singapore, 1976 – 2002

Mete Feridun[1] and Yaya Sissoko[2]

Abstract

This study examines the relationship between economic growth as measured by GDP per capita and foreign direct investment for Singapore, using the methodology of Granger causality and vector auto regression (VAR). Evidence shows that there is a unidirectional Granger causation from foreign direct investment to economic growth.

Keywords: Granger Causality, Vector Auto Regression, Economic Growth

JEL classification: C22, F21, O47

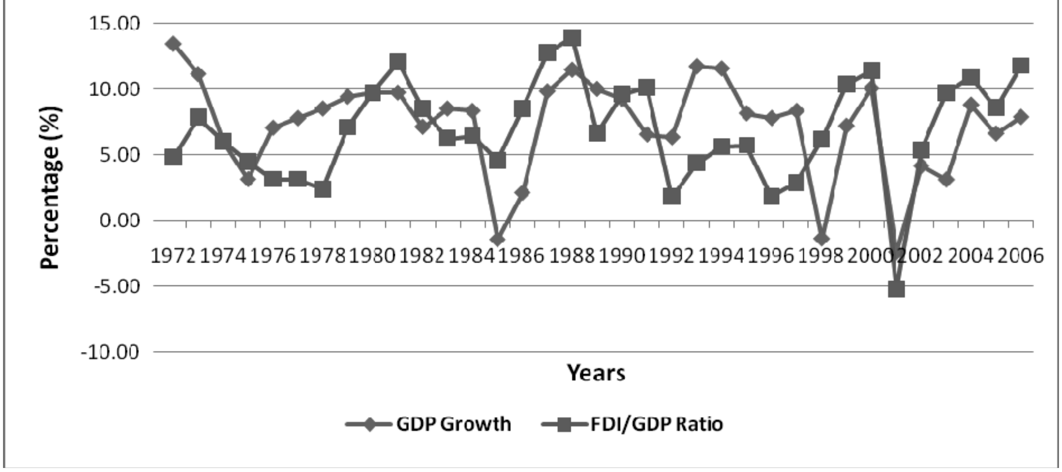
1. Introduction

Singapore, an island between Indonesia and Malaysia, is the smallest country in Southeast Asia. Singapore is one of the world's most prosperous countries with strong international trading links. Gross Domestic Product (GDP) per capita PPP (Purchasing Power Parity) for Singapore was US$24, 481 in 2003 while real GDP was growing at an average annual rate of 6 percent (Human Development Reports, 2005). This rapid economic growth in Singapore improves the social and economic welfare of the country. Most of this economic growth can be explained by an open trade policy promoting production and export and attracting foreign capital inflow into Singapore. Moreover, the government adopted upon independence in 1965 a pro-foreign investment and export-oriented economic policy to promote growth and development in Singapore.

This paper shows the causal relationship between Foreign Direct Investment (FDI) and economic growth in Singapore. In Figure 1, the annual growth rate of GDP and FDI-GDP ratio move closely together in Singapore with FDI-GDP ratio going down quickly as the growth rate of GDP declines. The decrease in the FDI-GDP ratio was even higher than negative 5% in 2001 when Singapore recorded a negative growth rate of GDP.

[1] Department of Banking and Finance, Faculty of Business and Economics, Eastern Mediterranean University, Gazi Magosa, Cyprus - email: mete.feridun@gmail.com
[2] Department of Economics, 213E McElhaney Hall, Indiana University of Pennsylvania, Indiana, PA 15705 - email: ysissoko@iup.edu

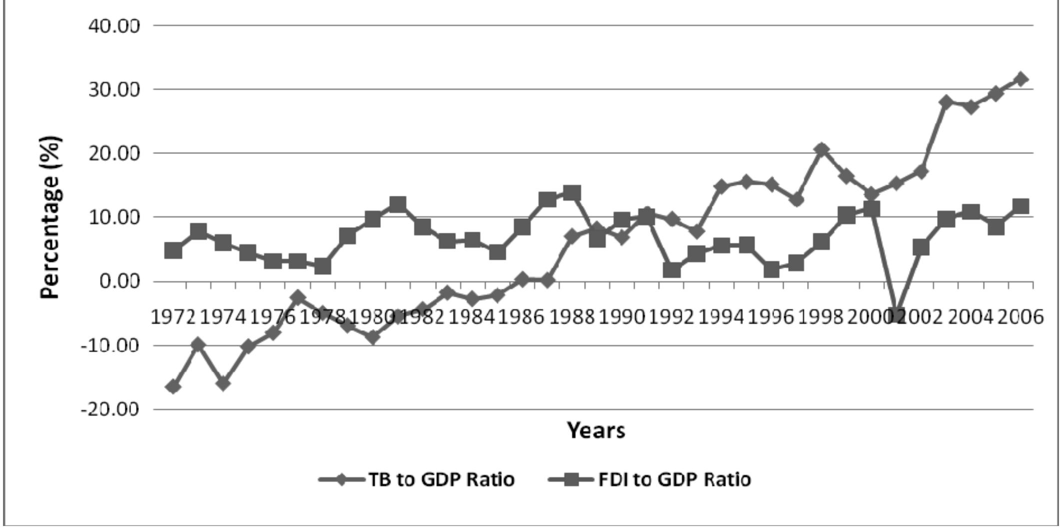
Figure 1: GDP Annual Growth Rate and FDI-GDP Ratio for Singapore



Moreover, Singapore achieved an average of high needed economic growth rate between 5% and 10% from 1972 to 2006 except in 1985, 1998 and 2001 in which years Singapore had a negative growth rate. The financial market crisis in Asia in 1997 and the 2001 U.S. recession might explain the negative growth rate of GDP recorded by Singapore.

Figure 2 displays the trade balance and FDI as a percentage of GDP for Singapore. In general, the trend for the trade balance and FDI as a ratio to GDP is rising over time with the latter being higher than the former until 1991. The ratio of the trade balance and FDI seems to move together within a 4-7% magnitude range over the 1972-2006 period.

Figure 2: Trade Balance and FDI as a Percentage of GDP for Singapore



In a survey article, De Mello (1997b) shows that the rate of growth of FDI inflows as a share of GDP in selective countries of Southeast Asia and Latin America has outpaced exports as a share of GDP over the period from 1980 to 1994.

Explosion of growth in FDI over the 1990's, especially in the developing countries, has inspired a stream of literature focusing on the impact of FDI on the dynamics of growth measured by GDP in the recipient country. The direction of the causality between growth rates and FDI may run either way. There are two dimensions with respect to the specification of the model about the causal links between FDI and GDP growth. The model specification establishes the causal link between FDI and the GDP growth rate or FDI and the log level of GDP[1]. Therefore, the objective of this study is to examine the presence of interdependence between GDP and FDI for Singapore. This study is relevant to Singapore because Singapore has been able to achieve high and sustainable economic growth since its independence from the U.K. in 1965.

The study is organized as follows. The second section provides a brief summary of the literature review. The third section discusses the material and methods. The fourth section displays the results and discussion and the last section concludes the paper.

2. Recent Literature

In the literature on the link between FDI and economic growth, Carkovic and Levine (2002) find no robust positive impact from FDI and the GDP growth rate. Further, they change the model specification to find no robust positive link between FDI and the log level of GDP. Moreover, Hansen and Rand (2006) improve the model specification of Carkovic and Levine by including country-specific trends in addition to country-specific level. They find a strong causal link between the FDI-to-GDP ratio (FDI ratio, for short) and the log level of GDP and that GDP Granger-causes FDI with no bi-directional causality. Their sample includes 31 countries with 10 countries in Asia (including Singapore), 11 countries in Latin America and the remaining 10 are African countries. Chakraborty and Basu (2002) examine the causality between FDI and output growth in India. Utilizing annual data from 1974-1996, they find that the real GDP in India is not Granger-caused by FDI and the causality runs more from real GDP to FDI.

Wang (2002) explores what kinds of FDI are most likely to contribute significantly to economic growth. Using data from 12 Asian economies over the period of 1987-1997, she finds that only FDI in the manufacturing sector has a significant and positive impact on economic growth and attributes this positive contribution to FDI's spillover effects. Borensztien et al. (1998) find that FDI, as an important vehicle for the transfer of technology with a minimum threshold of human capital stock in the host country,

[1] De Mello (1997b) provides a survey of studies establishing the causal link between FDI-to-GDP either via the log level of GDP (e.g., Bajonbio and Sosvilla-Revero (1994); O'Sullivan (1993); Lee and Mansfield (1996); Braunerhjelm and Svenson (1996); Wand and Swain (1995)) or through GDP growth (e.g., Wand and Swain (1995)).

contributes relatively more to economic growth than domestic investment. Blomstrom et al. (1994) argue that FDI has a positive growth effect when a country is sufficiently rich in terms of per capita income.

Ericsson and Irandoust (2001) examine the causal effects between FDI growth and output growth for four OECD countries applying a multi-country framework to data from Denmark, Finland, Norway and Sweden. The authors fail to detect any causal relationship between FDI and output growth for Denmark and Finland. They suggest that the specific dynamics and nature of FDI entering these countries could be responsible for these no-causality results.

De Mello (1999) attempts to find support for an FDI-led growth hypothesis when time series analysis and panel data estimation for a sample of 32 OECD and non- OECD countries covering the period 1970-1990 were made. He estimates the impact of FDI on capital accumulation and output growth in the recipient economy.

Liu, Burridge and Sinclair (2002) test the existence of a long-run relationship among economic growth, foreign direct investment and trade in China. Using a cointegration framework with quarterly data for exports, imports, FDI and growth from 1981 to 1997, the research finds the existence of a bi-directional causal relationship among FDI, growth, and exports. It is beyond the scope of the present study to review the literature on the FDI-GDP relationship. The interested reader should refer to de Mello (1997, 1999) for a comprehensive survey of the nexus between FDI and growth as well as for further evidence on the FDI growth relationship.

3. Materials and Methods

The econometric methodology firstly examines the stationarity properties of the univariate time series. The present study uses the Augmented Dickey-Fuller (ADF) (1979) unit root test to examine the stationarity of the data series. It consists of running a regression of the first difference of the series against the series lagged once, lagged difference terms, and optionally, a constant and a time trend. This can be expressed as:

$$\Delta y_t = \beta_1 y_{t-1} + \beta_2 \Delta y_{t-1} + \beta_3 \Delta y_{t-2} + \beta_4 + \beta_5 t \qquad (1)$$

The test for a unit root is conducted on the coefficient of y_{t-1} in the regression. If the coefficient is significantly different from zero then the hypothesis that y contains a unit root is rejected. Rejection of the null hypothesis implies stationarity.

Secondly, time series have to be examined for cointegration. Cointegration analysis helps to identify long-run economic relationships between two or several variables and to avoid the risk of spurious regression. Cointegration analysis is important because if two non-stationary variables are cointegrated, a VAR model in the first difference is misspecified due to the effect of a common tend. If a cointegration relationship is identified, the model should include residuals from the vectors (lagged one period) in the dynamic Vector Error Correcting Mechanism (VECM) system. In this stage, the Johansen (1988) cointegration test is used to identify a cointegrating relationship among the variables. Within the Johansen multivariate cointegrating framework, the following system is estimated:

$$\Delta z_t = \Gamma_1 \Delta z_{t-1} + \ldots + \Gamma_{k-1} \Delta z_{t-k-1} + \Pi z_{t-1} + \mu + \varepsilon_t: \quad t = 1, \ldots, T \tag{2}$$

where Δ is the first difference operator, z denotes a vector of variables, $\varepsilon_t \sim$ niid $(0,\Sigma)$, μ is a drift parameter, and Π is a $(p \times p)$ matrix of the form $\Pi = \alpha\beta'$, where α and β are both $(p \times r)$ matrices of full rank, with β containing the r cointegrating relationships and α carrying the corresponding adjustment coefficients in each of the r vectors. The Johansen approach can be used to carry out Granger causality tests as well. In the Johansen framework, the first step is the estimation of an unrestricted, closed p-th order VAR in k variables. Johansen (1988) suggested two tests statistics to determine the cointegration rank. The first of these is known as the trace statistic

$$N \quad \left\{ trace(r_0 / k) = -T \sum_{i=r_0+1}^{k} \ln(1-\hat{\lambda}_i) \right. \tag{3}$$

where, $\hat{\lambda}_i$ are the estimated eigenvalues $\lambda_1 > \lambda_2 > \lambda_3 > \ldots > \lambda_k$ and r_0 ranges from 0 to k-1 depending upon the stage in the sequence. This is the relevant test statistic for the null hypothesis $r \leq r_0$ against the alternative $r \geq r_0 + 1$. The second test statistic is the maximum eigenvalue test known as λ_{max}; we denote it as $\lambda_{max}(r_0)$. This is closely related to the trace statistic, but arises from changing the alternative hypothesis from $r \geq r_0 + 1$ to $r = r_0 + 1$. The idea is to try and improve the power of the test by limiting the alternative to a cointegration rank which is just one more than under the null hypothesis. The λ_{max} test statistic is:

$$\lambda_{max}(r_0) = -T \text{ in}(1 - \lambda_i) \text{ for } i = r_0 + 1 \tag{4}$$

The null hypothesis is that there are r cointegrating vectors, against the alternative of r + 1 cointegrating vectors. Johansen and Juselius (1990) indicated that the trace test might lack power relative to the maximum eigenvalue test. Based on the power of the test, the maximum eigenvalue test statistic is often preferred. According to Granger (1969), Y is said to "Granger-cause" X if and only if X is better predicted by using the past values of Y than by not doing so with the past values of X being used in either case. In short, if a scalar Y can help to forecast another scalar X, then we say that Y Granger-causes X. If Y causes X and X does not cause Y, it is said that unidirectional causality exists from Y to X. If Y does not cause X and X does not cause Y, then X and Y are statistically independent. If Y causes X and X causes Y, it is said that feedback exists between X and Y. Essentially, Granger's definition of causality is framed in terms of predictability.

To implement the Granger test, a particular autoregressive lag length k (or p) is assumed and Equations (5) and (6) are estimated by OLS:

$$X_t = \lambda_1 + \sum_{i=1}^{k} a_{1i} X_{t-i} + \sum_{j=1}^{k} b_{1j} Y_{t-j} + \mu_{1t} \quad (5)$$

$$Y_t = \lambda_2 + \sum_{i=1}^{p} a_{2i} X_{t-i} + \sum_{j=1}^{p} b_{2j} Y_{t-j} + \mu_{2t} \quad (6)$$

An F-test is carried out for the null hypothesis of no Granger causality $H_0 : b_{i1} = b_{i2} = \cdots = b_{ik} = 0, i = 1,2.$ $H_o : b_{i1} = b_{i2} = b_{ik} = 0$, i = 1,2 where, the F statistic is the Wald statistic for the null hypothesis. If the F statistic is greater than a certain critical value for an F distribution, then we reject the null hypothesis that Y does not Granger-cause X (equation (1)), which means Y Granger-causes X.

A time series with a stable mean value and standard deviation is called a stationary series. If d differences have to be made to produce a stationary process, then it can be defined as integrated of order d. Engle and Granger (1987) state that if several variables are all I(d) series, their linear combination may be cointegrated, that is, their linear combination may be stationary. Although the variables may drift away from equilibrium for a while, economic forces may be expected to act so as to restore equilibrium. Thus, they tend to move together in the long run irrespective of short run dynamics. The definition of Granger causality is based on the hypothesis that X and Y are stationary or I(0) time series. Therefore, the fundamental Granger method for variables of I (1) cannot be applied. In the absence of a cointegration vector, with I (1) series, valid results in Granger causality testing are obtained by simply first differentiating the VAR model. With cointegration variables, Granger causality will further require inclusion of an error term in the stationary model in order to capture the short term deviations of series from their long-term equilibrium path. Hassapis et al. (1999) show that in the absence of cointegration, the direction of causality can be decided upon via standard F-tests in the first differenced VAR. The VAR in the first difference can be written as:

$$N \quad \left\{ \Delta X_t = \lambda_1 + \sum_{i=1}^{k} a_{1i} \Delta X_{t-i} + \sum_{j=1}^{k} b_{1j} \Delta Y_{t-j} + \mu_{1t} \right. \quad (7)$$

$$N \quad \left\{ \Delta Y_t = \lambda_2 + \sum_{i=1}^{p} a_{2i} \Delta X_{t-i} + \sum_{j=1}^{p} b_{2j} \Delta Y_{t-j} + \mu_{2t} \right. \quad (8)$$

4. Results and Discussion

The present study employs data that consists of annual observations spanning the period between 1976 and 2002. All data are obtained from the World Bank WDI database and are transformed into logarithmic returns in order to achieve mean-reverting relationships, and to make econometric testing procedures valid. FDI is net inflows of investment to acquire a lasting management interest (10 percent or more of voting stock) in an enterprise operating in an economy other than that of the investor. It is the sum of equity capital, reinvestment of earnings, other long-term capital, and short-term capital as shown in the balance of payments. This series (FDI) shows net inflows in the reporting economy. Data are in current U.S. dollars. GDP per capita, on the other hand, is Gross Domestic Product divided by midyear population. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in constant U.S. dollars. Table 1 shows the descriptive statistics.

Table 1: Descriptive Statistics

	GDP	FDI
Mean	1.545022	7.961727
Median	2.215338	9.213
Maximum	4.932729	11.1
Minimum	-2.67133	1.998
Std. Dev.	2.813073	3.15993
Skewness	-0.55246	-0.79574
Kurtosis	1.924972	2.388918
Jarque-Bera	1.319233	1.411518
Probability	0.612694	0.587747
Sum Sq. Dev.	71.29173	89.95642

Table 2 shows the results of the ADF unit root tests in levels and in first differences of the data. Strong evidence emerges that all the time series are I (1) at the 1% and 5% significance levels.

Table 2: Augmented Dickey-Fuller Unit Root Test Results

	Test with an intercept		Test with an intercept and trend		Test with no intercept or trend	
	Levels	1st differences	Levels	1st differences	Levels	1st differences
FDI	2.498277	-10.8764	1.345764	-6.70895	1.135974	-7.38527
GDP	2.590962	-7.4864	0.506604	-12.9129	3.047283	-10.4731
CV* (1%)	-4.2816	-4.35153	-5.07437	-5.18126	-2.99667	-3.01643
CV (5%)	-3.37473	-3.40271	-4.09679	-4.14363	-2.17715	-2.18048

* McKinnon Critical Value

The lag length was determined using Schwartz Information Criteria (SIC)

Table 3 presents the results from the Johansen cointegration test among the data sets. Neither the maximum eigenvalue nor the trace tests rejects the null hypothesis of no cointegration at the 5% level.

Table 3: Johansen Cointegration Test Results

Null hypothesis	Trace statistic	5% critical value	Maximum eigenvalue statistic	5% critical value
r = 0	32.7112	40.44	20.7220	28.6228
r < = 1	12.568	23.93	9.7811	22.3411

r is the number of cointegrating vectors under the null hypothesis.

The outcome of the Granger causality tests is shown in Table 4. Results of the Granger-causality test show that the null hypotheses of FDI does not Granger-cause GDP per capita is rejected in 1 and 2 year lags, at the 5% and the 10% levels, respectively. On the other hand, the null hypotheses of GDP does not Granger-cause FDI is not rejected. This leads us to the conclusion that there is only a one-way causality running from FDI to GDP.

Table 4: Granger Causality Test Results

	F - Statistics			
Null hypothesis	Lag 1	Lag 2	Lag 3	Lag 4
FDI does not Granger-cause GDP per capita	10.4221**	6.1223*	0.0021	0.5225
GDP per capita does not Granger-cause FDI	0.142271	0.9212	1.8272	0.3996

* Reject the null hypothesis at the 10% level.
** Reject the null hypothesis at the 5% level.
*** Reject the null hypothesis at the 1% level.

5. Conclusion

This study examines the relationship between FDI and GDP per capita in the economy of Singapore, using the methodology of Granger causality and vector auto regression (VAR). Strong evidence emerges that the economic growth as measured by GDP in Singapore is Granger-caused by the FDI. This means that there is a uni-directional causality running from FDI to GDP. There is no evidence that the causality link between FDI and GDP is bi-directional in Singapore. Results further suggest that Singapore's capacity, including but not limited to free trade zones, trade regime, tax incentives, infrastructure quality, the human capital base and the transfer of technology, to progress in economic development will depend on the country's performance in attracting foreign capital. Trade and financial restrictions can indeed impede the inflow of foreign funds into host countries.

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